MACHAKOS UNIVERSITY

University Examinations 2021/2022

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FOURTH YEAR SUPPLEMENTARY/SPECIAL EXAMINATION FOR BACHELOR OF EDUCATION (SPECIAL NEEDS EDUCATION) AND BACHELOR OF EDUCATION (SCIENCE)

SCH400: COMPARATIVE STUDY OF TRANSITIONAL ELEMENTS

DATE: 15/3/2022 **TIME: 11:00-1:00 PM**

INSTRUCTIONS:

- The paper consists of **two** sections.
- Section **A** is **compulsory**.
- Answer any **two** questions from section **B**.

Section A - Compulsory

QUESTION 1

a) You are provided with an element X which has 30 protons. With reasons classify element X as a d-block element, transitional metal or both? (3 marks)

b) State and explain the general trends for each of the following properties down the groups for transitional elements (4 marks)

(i) Oxidation states

(ii) Melting points

c) By use of a scheme illustrate how pure vanadium is extracted from its ores (6 marks)

d) Explain why Lanthanides elements do not form compounds in oxidation states higher than +3 (3 marks)

(e) Calculate the spin only magnetic moment of M^{3+} (aq) ion (Z=26) (3 marks)

(f) Account for the following observation / properties of transitional metals

(i) Formation of colored compounds by some transitional elements (2 marks)

(ii) The high melting points and boiling points, hardness, high electrical and thermal conductivities , (3 marks)

(iii) Formation of complexes by transition elements (3 marks)

(iv) Catalytic activities demonstrated by some transition elements alloys or compounds especially the late transition series (3 marks)

Section B

QUESTION 2

(a) Group 12 metals are not typical transitional elements (3 marks)

(b) Name and briefly discuss the three processes involved in metallurgy (9 marks)

(c) Write the electronic configuration of the following atoms or ions (6 marks)

(i) Cr^{3+} (Z = 24)

(ii) Sm (Z = 62)

(iii) U (Z = 92)

(iv) Zn^{2+} (Z = 30)

(d) Explain what you understand by the following terms (2 marks)

(i) Diamagnetic substances

(ii) Lanthanide contraction

QUESTION 3

a) Give a possible explanation for the following observations

i)Across the first of transition elements from left to right the +2 oxidation states becomes more stable in comparison with the +3 (3 marks)

ii) The second ionization enthalpy is unusually high for Cr and Cu (3 marks)

(b) The Kroll process of titanium extraction is expensive but it is still in use. Using $FeTiO_3$ as the mineral of choice for extraction

(i) Explain how titanium is obtained from the mineral (5 marks)

(ii) Explain why the process is likely to be expensive (3 marks)

(iii) Give 2 reasons why titanium extraction is still in use in spite of high production cost (2 marks)

(c) By use of equations show to ways in which metallic Cr is obtained from Cr(III) oxide (4 marks)

QUESTION 4

a) You have been tasked to prepare a popular transition metal catalyst used for polymerization of terminal alkenes from a concentrated rutile ore. Briefly explain how you would go about the process (4 marks)

b) Two of the group VIII metals (Fe, Ru, and Os) form stable oxides in the +8 oxidation state. Respond to the questions below supporting your answers with sound chemistry facts:

(i) Identify these metals;

(ii) predict the stoichiometry/formula of the oxides;

(iii) describe the general physical properties, type of bonding, and decide whether they are acidic or basic oxides (6 marks)

c) Clearly explaining your reasoning, arrange the following ions in order of decreasing ionic radius Pt^{4+}, Hg^{2+}, Fe^{2+}, and Fe^{3+} (4 marks)

d) For each reaction below explain why the indicated products form in reference to oxidation state, reduction/oxidations and structure and bonding (6 marks)

i. $TiCl_{4(l)} + 2H_2O_{(l)} \rightarrow TiO_{2(s)} + 4HCl_{(aq)}$

ii. $2KMnO_{4(aq)} + 2H_2SO_{4(l)} \rightarrow Mn_2O_{7(l)} + 2KHSO_{4(aq)} + H_2O_{(l)}$

QUESTION 5

a) Describe the sulphate process of producing pigment grade TiO_2. Why is this method not suitable when rutile is used as the ore (6 marks)

b) Write a balanced net ionic equation for each of the following reactions

(i) When NaOH is added a drop at a time to a solution $ZnCl_2$ a gelatinous white precipitate forms which dissolve in excess NaOH to give colorless solution (4 marks)

c) State and explain the variation of atomic radii across the first transition series (4 marks)

d) Distinguish between a mineral and an ore (2 marks)

e) Explain by use of equations how disproportionation reaction can be applied in preparation of potassium permanganate from magnesium dioxide (4 marks)